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Statement of

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Committee on Science
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Mr. Chairman and members of the Subcommittee, I am Stephen Merrill, Executive Director of the National Acadmies' Program on Science, Technology, and Economic Policy (STEP) , and I am here representing an Academy panel, chaired by Alan Schrriesheim, former Director of Argonne National Laboratory, that recently issued a report, ***Aeronautics Innovation: NASA's Challenges and Opportunities***, copies of which have been supplied to the Subcommittee. I was the project director. As you know, the Academy is charged by congressional charter of 1863 with providing independent, objective technical and policy advice to the government.

The Aeronautics Research Mission Directorate (ARMD) of NASA – the first "A" in NASA -- seeks to create an environment that fosters the application of the results of its R&D program in advanced airframe, engine, emissions, air safety, and air traffic control technologies. Adoption of the technologies developed by NASA is dependent on a variety of government and private sector clients or customers – the airframe and aircraft engine industries, the military services, and the regulatory and operational arms of the Federal Aviation Administration. To help produce a more robust innovation climate, ARMD under the previous associate administrator asked the National Academies' Science, Technology, and Economic Policy (STEP) Board to identify from the private and public sectors practices, tools, and methodologies that could maximize NASA's ability to influence innovation outcomes positively.

The Academies assembled a committee composed of experts in private sector technology management, public policy and administration, and economics. A distinctive feature of this committee was that although it included people experienced in different areas of aeronautics technology development it was not limited to stakeholders but also included experts in information technology, optoelectronics, energy, and materials and their application in industries

quite remote from aviation. As a result, although we lacked expertise in every facet of ARMD's program we have a somewhat broader perspective than some other observers and participants. We organized two public workshops, visited three of the NASA research centers engaged in aeronautics R&D (Ames, Glenn, and Langley), and we interviewed center, program, and project managers and others knowledgeable about NASA and the aerospace industry. Finally, we reviewed the large volume of reports published in the past few years on the aerospace industry and government policies affecting it. Although we did not have the benefit of the results of the Academies' Decadal Survey of Civil Aeronautics, we did consult other recent work of the Aeronautics and Space Engineering Board, the Commission on the Future of the Aerospace Industry, the Aerospace Industries Association, the National Institute of Aerospace, and numerous other public and private bodies.

By most of these accounts, the nation has pressing economic and security needs in aviation ranging from meeting increasing international competition in aircraft and engines to expanding air travel capacity while maintaining safety and reducing adverse environmental impacts. In addressing these needs, NASA can play an important role that is not served by other parties, and previous Academy reports have found that NASA's R&D portfolio generally exhibits high technical merit. In spite of this broad support for a robust federal – and, in particular, NASA -- role in civil aeronautics technology development, the aeronautics research budget has declined steadily over several years. This is shown in the accompanying figure, at least through 2000.

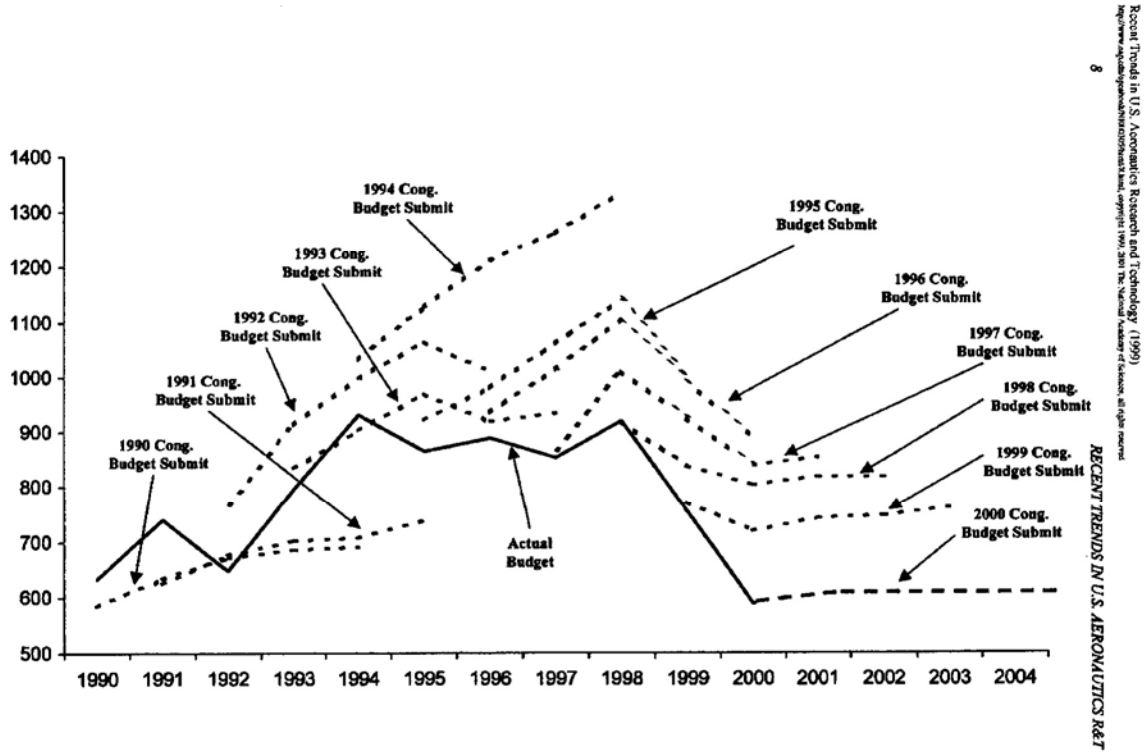

Figure 1-1. NASA Aeronautics R&D Budget Requests and Actual Budgets, 1990-2000 (constant dollars in millions)

Source: NASA.

There is, in fact, a growing discrepancy between the needs said to be served by NASA's program and the resources available to it. Yet there is no agreed upon articulation of what the program should be trying to accomplish in this budget environment. Lacking clear direction from policymakers, ARMD and its predecessors have been attempting to do as much or more with less, spreading resources too thinly to ensure their effectiveness and the application of the R&D results.

Why did this concern our committee, which was charged with the task of recommending better techniques for transitioning technology? The answer is precisely because modern innovation management in a resource-constrained environment has as a first principle identifying and adequately supporting the highest priority projects and winnowing out the less important

ones. Unless ARMD, in consultation with all stakeholders, develops a clear mission focus in better alignment with the resources available to it, any other managerial advice we might offer is of little utility in helping meet the nation's needs in aeronautics.

This issue, of course, came to a head last year when the President's sharply reduced FY 2006 request for ARMD forced a radical scaling back of plans for the vehicle systems R&D program (VSP), limiting it to the pursuit to the demonstration stage of only four of the technology development activities in its portfolio. In the FY 2006 Appropriations Act, Congress rejected the proposed cut and restored the ARMD budget to its FY 2005 level or slightly above. Now the administration is back with a proposed 20 percent budget reduction in FY 2007 and a new plan to refocus the aeronautics program on fundamental research. Meanwhile, the NASA Authorization Act of 2005 called on the administration to prepare a policy statement on aeronautics, presumably so that program's future direction can be thoroughly aired and some sort of executive branch-congressional consensus developed. We believe that objective is critical to move the program off what the committee considers "a glide path to irrelevance."

Our committee was not asked nor constituted to redefine the government's role in civil aviation nor to recommend what NASA's aeronautics R&D priorities should be or how the program should be reorganized. We do, however, offer some general guidance in our report.

- A strategic focus for NASA aeronautics that is in line with its budget, personnel, and technical capabilities is likely to result in a reduced mission scope and portfolio, but one with greater potential to achieve innovation in air transportation.
- The portfolio should reflect stakeholder needs. There should be ongoing consultation with customers and users. In our view the behind-closed-doors development of the FY 2006 VSP revision, whatever its technical merits, neglected this lesson.

- The portfolio should also be closely aligned with the core competencies of the NASA research centers and those of the external performers that the agency supports.
- There is a strong case for NASA to continue to pursue "public good" areas of R&D work – those closely related to safe and efficient air traffic management, environmentally more benign aviation operations (i.e., pollution and noise reduction), and the certification of equipment and standards. These are areas where the market is unlikely to produce the optimum level of innovation and where NASA's technical capabilities are in some respects superior to those of regulators and operators.
- If ARMD is to sustain its relevance and support, it should continue to have a portfolio quite diversified in terms of the stage of technology being developed, even if that means significantly fewer projects. Many of the users of NASA-developed technologies have limited technical capability and/or operate in a risk-averse environment. In either case they require outside suppliers to deliver fairly well-proven technologies.
- Refocusing the NASA aeronautics program exclusively on fundamental research may appear to be a reasonable strategy given the current outlook for funding, but it risks losing the support industry stakeholders, without which the program cannot compete effectively for resources.

If the aeronautics R&D program is more strategically focused, the committee believes there are a number of principles derived from innovation management theory and public and private sector practice that would facilitate implementation of NASA-developed aeronautics technologies. We categorize these as transition management tools, flexible personnel practices,

and financial management to minimize the disruptive effects of externally imposed demands on resources.

MANAGEMENT FOR TRANSITION

ARMD should implement and regularize for all relevant projects organization-wide a series of management tools aimed at fostering technology transition to users.

- ARMD should cultivate close relationships with external customers and users, engaging them very early in jointly conceptualizing, planning, and prioritization of R&D activities and sustaining regular involvement through the implementation phase.
- ARMD should use decision processes, sometimes referred to as decision gate processes, at predetermined points to establish common expectations among customers, leaders and the technical team throughout the development process, to clarify goals, schedules, deliverables, concrete target performance metrics and review templates, and to set decision criteria and force accountability of all constituents involved. Documented planning for technology transition (i.e., hand-off) to external stakeholders should be a universal managerial practice for all ARMD R&D projects.
- ARMD needs to work aggressively to solidify its reputation as a trustworthy, reliable partner.
- The Joint Planning and Development Office (JPDO), the multi-agency entity charged with developing a plan for a modernized air traffic control system, may be a model for future ARMD technology development projects requiring close external collaboration. The committee could not evaluate the experience with JPDO to date, but it found the concept sufficiently promising to consider employing in other contexts.

- The variety of technologies and the diversity of stakeholder capabilities require increased ARMD flexibility and variability with regard to project time horizons and stage of technology development.

PERSONNEL MANAGEMENT PRACTICES

ARMD should implement more flexible personnel practices, increase incentives for creativity, and actively manage existing constraints on staffing decision-making to minimize their innovation inhibiting effects. Several of these are authorized by the Space Act of 1958 but are in quite limited use.

- ARMD should increase rotation and seconding of personnel to and from its several research centers and its external partners as a tool for enhancing staffing and access to needed competencies, securing early engagement of partners, and facilitating technology transitioning.
- ARMD should foster external customer contact early in and throughout the careers of technical personnel.
- ARMD should pilot test a dual track, pay-for-performance program similar to that in place at the Air Force Research Laboratory.
- ARMD should allow its R&D personnel some small fraction of their time for "free thinking" and encourage its use by organizing regular events to showcase employee ideas; external stakeholders should be invited to participate in these events.
- NASA should expand its Centennial Challenges program to offer high profile aeronautics prizes of a magnitude sufficient to generate considerable participation and public attention.

FINANCIAL MANAGEMENT

ARMD should structure financial management to minimize the disruptive effects of externally imposed demands on resources and one-size-fits-all accounting rules.

- NASA should modify full-cost pricing for ARMD test facilities use, with charges more closely aligned with marginal costs.
- AMRD should work with the Office of Management and Budget and Congress to establish separate centrally-funded budget lines for national infrastructure and facilities maintenance.
- Because mid-stream changes are in the nature of research and development ARMD should establish greater budget and milestone flexibility through centrally-funded pools and contingency accounts.
- ARMD should explore establishing Working Capital Fund structures for wind tunnels and aeronautics R&D services.
- ARMD should negotiate with congressional sponsors of directed funding and recipients to align mandated activities better with established programs. If this is not possible, directed funding should be separated in budget accounting and in management.

Even if NASA implemented these recommendations regarding transition planning and personnel and financial management, successful innovations would still be impeded by the policy differences and budget realities facing ARMD and its research centers. Until the divide is bridged and a consensus mission supported by adequate resources, this committee's management advice, although potentially useful, is a secondary priority.

Thank you, Mr. Chairman, for this opportunity to present our findings and recommendations to the Subcommittee. I would be pleased to answer any questions the members have.

Committee on Innovation Models for Aeronautics Technologies

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